Ubiquitous Indoor Multi-Carrier Cellular Coverage with Oceus MoCN Neutral Host Network Solution

HOW OCEUS SOLVES IN-BUILDING CELLULAR COVERAGE AFFORDABLY FOR ANY BUILDING SIZE

AT A GLANCE

CHALLENGES

- 80% of cell phone use is indoors
- Indoor cell signals impeded by low-e building materials
- Absence of viable solution for small & medium buildings

OUTCOMES

- Reliable indoor cell coverage for multiple carriers simultaneously
- Affordable, scalable solution for small & medium buildings
- Revenue opportunities for building owners and carriers

If you have ever experienced challenges finding cell phone coverage when indoors, you are not alone. Indoor cell coverage continues to be a painful issue for enterprises and carriers alike, and based on market forces and technology trade-offs, the problem will only grow worse. It is a twofold issue: signal strength and capacity. While solutions exist for large venues like stadiums and airports with very large concentrations of people, the relative costs can become a prohibitive burden for small and medium buildings to deploy.

Oceus, the leader in deploying mobile cellular solutions in challenging environments where reliability and data security is paramount, offers an intelligent **Neutral Host Network** solution that can extend coverage for multiple mobile network operators (MNOs) simultaneously on a unified in-building infrastructure. This provides more affordable options for small and medium-sized buildings to integrate multiple MNOs onto an in-building solution, and is deployable in weeks (versus months-to-years for some alternatives). It also creates revenue opportunities for commercial real estate developers and competitive differentiation for hospitality venues, and lays the high-capacity networking foundation for industries such as healthcare to deploy smart technologies via Internet of Things, Artificial Intelligence, and Robotics.

This paper describes the compounding problems with indoor cellular coverage, limitations of existing solutions, key drivers for a paradigm shift in delivering indoor cell coverage, opportunities for building owners and facility managers, and how Oceus solutions provide reliable indoor cellular coverage for multiple operators, with a more efficient, affordable and rapid-to-deploy solution.

Indoor Cell Phone Usage is Massive, and Yet Coverage Is Still Lacking

Carriers have spent years and enormous amounts of money expanding their networks by building cell towers to improve outdoor coverage. There have been great coverage advancements in dense urban areas, and fairly seamless coverage in rural areas. However, reliable continuous coverage indoors has plagued users, and is only becoming more serious as our world becomes more and more connected.

Recent studies have shown that **80% of cellular use is indoors**, with cell phones replacing landlines, and people staying connected virtually all the time, at home, at play, at work, and their usage continues to grow. In the US, smartphone data usage averaged 8.5 Gigabytes per month, and is predicted to grow to 45 GB per month by 2025. By the end of 2023, there will be 8.7 billion mobile devices in use globally, and 4.4 billion Internet of Things devices. In the US that equates to 13.4 connected devices per person. This growth points to significant capacity issues as demand for connectivity rises but indoor public cellular signal strength does not.

The Clash of Spectrum and Low-E Glass: It's Physics

While increasing demand for connectivity creates a capacity issue, it's the physical world that impedes signal strength indoors. Modern building materials such as steel and concrete, and the use of low emissivity (Low-E) glass that minimizes heat dissipation from buildings, have been excellent at blocking cell signals from outdoor towers. This has been an issue for 4G and will get even worse for 5G users because of the high frequency spectrum it will utilize the most.

The advancements of 5G are significant and are largely possible because of the higher frequency band in which it operates. Mid-band 5G, which includes about 60% of networks, operates in the higher 1-6 GHz frequency range, and can accommodate an incredibly large amount of data. When combined with other engineering advancements, it can carry thousands of times as much data as 4G and earlier generations that utilized the lower cellular bands. However, the millimeter waves generated at the higher frequencies are terrible at penetrating walls and Low-E glass.

With more people using more data indoors, and with signals having more difficulty reaching subscribers, the indoor connectivity issue is compounding.

-Indoor coverage is a must have for enterprises
-Efficient integration of multiple MNOs
- Oceus MOCN solution creates value for building owners and MNOs

Network Infrastructure Sprawl

THERE ARE EXISTING SOLUTIONS TO INDOOR CONNECTIVITY ISSUES THAT ARE VIABLE FOR CERTAIN USE CASES, EACH WITH THEIR STRENGTHS BUT COME WITH LIMITATIONS THAT INHIBIT THEIR BROAD AND FUTURE VIABILITY.

Distributed Antenna Systems (DAS)

Large structures over 500,000 square feet, such as stadiums, convention centers, and airports, often deploy Distributed Antenna Systems (DAS) that extend public cellular coverage inside their facilities for several carriers simultaneously. These systems have historically been funded by Mobile Network Operators (MNOs) in large high-traffic areas where they can reach the most subscribers for the least investment.

The facility or a third-party service provider typically negotiates agreements with multiple MNOs to share infrastructure hardware and costs, aggregating network installation and management challenges to achieve adequate coverage and capacity.

There are several issues with DAS systems that make them more costly for smaller facilities, such as those under 500,000 sq. ft.: Each antenna needs fiber or coaxial cabling to connect to the signal source, which is a significant part of the cost and can be disruptive to install; and finalizing multiple MNO agreements, as well as implementing multiple backhaul solutions, which can take 12-18 months to complete.

All these challenges make DAS systems potentially less suitable for small and medium buildings. Considering that 80% of all commercial real estate is smaller than 500,000 sq. ft., it means there are a lot of users struggling with connectivity, and MNOs often bear the brunt of subscriber frustration over this issue, and building owners are caught in the middle trying to improve their properties with basic connectivity, advanced services or otherwise trying to deliver high-value services for their own building's occupants, or a tenant.

Small Cells

A miniaturized version of macro cell base stations, a small cell connects back to an MNO network via secure tunnels. They can be installed throughout facilities to support connectivity for hundreds of users. However, small cells are MNO-specific so for adequate public cellular coverage, small cells for each carrier must be installed, and placement can be a complex undertaking involving detailed engineering design, and implementation.

Wi-Fi

As a mature wireless connectivity solution, Wi-Fi is likely already installed in most homes and commercial buildings. Wi-Fi calling and VoIP services solve many indoor wireless data and voice connectivity issues. But Wi-Fi has capacity limits which can be easily overwhelmed and Wi-Fi lacks tight security, which makes it unsuitable for emerging Internet of Things applications, like surveillance cameras in buildings, and heart monitors in hospitals, for always-connected patient monitoring. Critical operations need rock-solid reliable and secure connectivity in-building to be effective, and Wi-Fi doesn't scale for that kind of performance.

Private 4G/5G

The rise of private cellular networks, running on 4G or 5G, delivers tremendous benefits to organizations in industries like manufacturing, logistics, and healthcare, with similar features of public cellular, but exclusively for private internal use. Private 4G/5G networks offer deterministic quality of experience, indoor-outdoor mobility, and higher security - all at an economically viable cost and without operator dependency. Private 4G/5G has high-speed, high reliability, and ultra-low latency, to enable business critical applications leveraging IoT, AI, AR/VR, and robotics.

However, devices are securely provisioned using network-exclusive SIMs. So, employees, contractors, and guests attempting to use their personal cell phones and devices will still have challenges with indoor public cellular connectivity from their respective mobile service providers.

Unfortunately, enterprises today have no choice but to have a sprawl of network infrastructure to meet diverse and competing business needs like voice and data connectivity for staff and guests, and connectivity for growing critical operation automation needs. Often, they have three totally isolated networks: Wi-Fi for regular guest connectivity and day to day operations, DAS or small cells to boost indoor public cellular coverage for guests, and private 4G/5G for business-critical operations. This hodgepodge of solutions is complicated to consistently secure and manage and is not a scalable and cost-efficient approach. The crux of this issue is a **lack of unified network infrastructure for public and private cellular networks that can support most business use cases**.

However, advancements in network function virtualization and the relatively new availability of lightly licensed spectrum creates the opportunity for an effective indoor connectivity solution that enables a unified network approach.

Oceus MOCN Neutral Host Network Solution

At Oceus, we have been building out private cellular networks for over a dozen years, especially for mission-critical applications in challenging environments where reliability and data security are paramount. Our success is in providing mobile communications support systems for high-stakes missions and business cases from public- and private-sector enterprises and emergency service providers who trust Oceus with their critical operational missions where they need to have extremely reliable and highly secure communications systems. ***We understand challenges with coverage.***

While DAS, small cells, and Wi-Fi satisfy specific use cases, Oceus offers an alternative solution ideal for small-to-medium sized buildings that delivers highly secure, reliable, and cost-effective indoor voice coverage. It is a multi-operator **neutral host network** (NHN) using **CBRS** shared spectrum and a **multi-operator core network** (MOCN) gateway, which cost-effectively delivers strong cell signals to indoor locations of any size. CBRS, Citizen Broadband Radio Service, is a lightly licensed shared spectrum band in the 3.5GHz frequency range that is available for commercial use at low cost, and without requiring the involvement of a mobile network operator. Because CBRS is carrier neutral, it makes it the ideal band for a flexible and feature-rich neutral host solution at a much lower cost than a DAS.

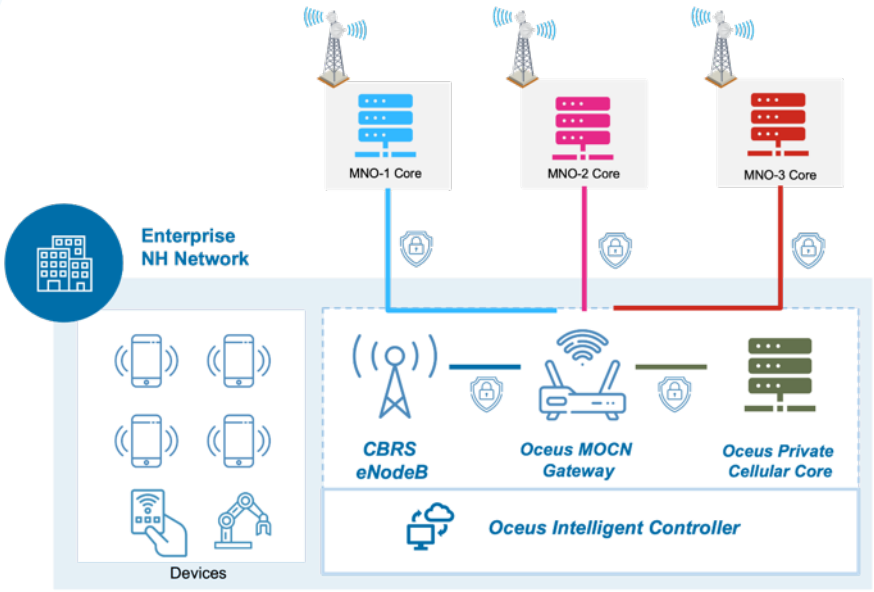
The Oceus CBRS-based neutral host network is a single shared network that provides services to subscribers of multiple mobile network operators. The Oceus MOCN allows multiple MNOs to share a common RAN network infrastructure while maintaining their own individual core. This extends MNO coverage without having to invest in additional radio signal source infrastructure. This can be particularly useful in areas where it may not be economically feasible for each MNO to deploy its own RAN network.

The Oceus MOCN achieves cellular capacity through cell sharing to achieve coverage without deploying multiple DAS signal sources or multiple small-cells around a building. Network capacity can be evenly shared, first come first served, or segmented for each operator, offering guaranteed levels of service based on the agreements with the MNOs.

The Oceus MOCN Neutral Host Network supports voice and data, and all emergency services are operational. Encryption is from eNodeB (CBRS small cells) to the MNO core, and all MNO public cellular and private cellular traffic is completely isolated.

Oceus Solution Proven In the Lab

- **Seamless handoff**
- **Fully functional emergency services**
- **Encryption from eNodeB to MNO core**
- **All MNO public cellular & private cellular traffic completely isolated**



Oceus MOCN Neutral Host Network Solutions

Our neutral host network solution is spectrum agnostic, meaning we work with CBRS and directly with carrier services, whether for private network use or leveraging public networks. We have strategic partnerships with global mobile operators, which aids in the fast deployment of a MOCN neutral host network. An Oceus MOCN Neutral Host Network can deploy in a matter of weeks versus 12-18 months to deploy a DAS.

Our proprietary software-defined network infrastructure includes our **Oceus Intelligent Controller** (OIC), which eliminates the complexities of deploying and managing an NHN. Utilizing artificial intelligence and machine learning, the network intelligently optimizes for peak coverage and performance.

Our patented technology achieves demanding network performance benchmarks: business-critical reliability, universal mobility, anywhere-anytime connectivity, broadband bandwidth, and autonomous cybersecurity. The OIC makes MOCN neutral host networks fast and easy to deploy and scale by removing barriers to easily integrate with existing network infrastructure.

SHARED INFRASTRUCTURE FOR NEUTRAL HOST AND PRIVATE 4G/5G

A single shared infrastructure can boost indoor coverage for public cellular as well as provide private cellular connectivity for enterprises at reduced costs with a reduced burden. With the Oceus MOCN NHN equipment already on the premises, a private cellular network can be established with very little additional cost. Our advanced private 5G network infrastructure is focused on mobility, security, and performance needed to deliver seamless connectivity for smart technology innovations such as **Internet of Things (IoT), Industry 4.0, Artificial Intelligence (AI), Augmented/ Virtual Reality (AR/VR)**, and **Robotics**. Mission-tested in demanding, austere, sensor-dense, remote, and complex environments, Oceus Private 5G solutions ensure mobile communications continuity in-building, campus-wide, and on-the-move. Our neutral host network solution is spectrum agnostic, meaning we work with CBRS and directly with carrier services, whether for private network use or leveraging public networks.

Opportunities for MNOs, Properties, and Organizations

Resolving indoor cellular coverage issues helps organizations meet current challenges, and also lays the groundwork to implement advanced technologies that bring opportunities with new use cases.

FOR MOBILE NETWORK OPERATORS

There are hundreds of thousands of small to medium sized buildings with over 97 billion square feet of commercial indoor spaces, struggling with indoor cell coverage. At about one-third of the cost of providing signal source for a DAS, expanding cell coverage indoors in small-to-medium properties is more affordable with an Oceus MOCN neutral host network. This can become very attractive to MNOs, who can now provide continuous indoor coverage for their subscribers. The Oceus MOCN NHN gives MNOs increased capacity at a broad range of locations, and it offloads traffic from their cellular infrastructures. It also helps with subscriber retention from dramatic improvement in customer satisfaction.

Connectivity from mobile devices to their carrier's network is seamless, with continuity of service levels between subscriber and MNO. The Oceus MOCN neutral host network gives carriers the ability to more cost-effectively augment their coverage into elusive indoor spaces.

FOR COMMERCIAL REAL ESTATE

At a time when commercial properties are challenged to find tenants in this work-from-home culture, having reliable indoor cell coverage can become a key competitive advantage. Diverse occupants can benefit from improved productivity, smart utility management, green efficiencies, and enhanced security.

Commercial property owners can provide and attribute increased value to their tenants by extending MNO coverage into their properties. Business models can also exist for large venues where the building owner sets up and manages the NHN and allows carriers access for a fee or offloading to a third party solutions provider who manages all aspects of the NHN.

Additionally, an Oceus private 4G/5G network with the same infrastructure enables commercial real estate owners to implement smart security, smart amenities, and utility controls, all competitive value-added features that occupants highly value and for which they will pay a premium.

FOR HOSPITALITY

Hotels have short-stay visitors using their phones and tablets for games, videos, and work, and who all come with distinct carrier relationships. Reliable connectivity is a critical competitive differentiator. While Wi-Fi can satisfy many visitors' email and online use cases, the Oceus MOCN NHN solution has a smaller footprint than Wi-Fi with greater security, dedicated performance, and seamless mobility traveling to and from the hotel.

Additionally, an Oceus private 4G/5G network in a hotel can support many advanced digital applications like smart thermostats and key systems with remote

Opportunities for MNOs, Properties, and Organizations

monitoring, video surveillance for enhanced safety, and asset tracking for things like luggage tags and cleaning carts.

FOR HEALTHCARE

With over 6,000 hospitals with 1.2 billion square feet, signal interference is even more extreme with hundreds of monitors, imaging machines, testing labs, and an endless array of electronics. Coverage issues can be critical for doctors and nurses, who are relying more and more on mobile devices to record electronic health records, and to be reachable in life-and-death situations. And patients and guests are all bringing in their own devices, straining already limited capacity.

An Oceus MOCN NHN delivers reliable indoor and outdoor voice communications, for patients, their guests, and hospital staff. With Oceus infrastructure already in place, hospitals can add private 4G/5G networking to implement technology advancements focused on improving patient care and operational efficiencies and extend care outside the hospital. Untethered patient monitoring with continuous connectivity from hospital to home via Internet of Medical Things devices, autonomous electronic healthcare record updating and analysis via AI, augmented training and virtual medicine via AR/VR, and remote and mobile clinical support via cloud computing, all require high-bandwidth, low-latency, highly secure and reliable connectivity delivered by Oceus private 4G/5G network solutions.

Oceus MOCN Neutral Host and Private 4G/5G network solutions are the future of indoor connectivity. With 90 billion square feet of uncovered connectivity in small and medium buildings, MNOs have a tremendous opportunity to expand their indoor coverage. Oceus solutions are fast and cost-effective options to deploy in weeks (versus months-to-years with other solutions), and are scalable, adaptable, secure, and resilient to support current and future operations and use cases.

Partnering with **Oceus** for Your Critical Cellular Connectivity Needs

Oceus collaborates with customers to solve their unique challenges and strategic outcomes. Our solutions include a combination of 4G/5G core, radios, MoCN gateway, multi-access edge compute platform, a choice of different spectrum options, and an AI-based intelligent orchestration software that ensures unique site-specific performance needs, optimizing the total cost of ownership. It can be a dedicated network incorporating a complete hardware and software system on premise, integrated and managed along with the organization's network infrastructure. Or it can be a cloud-based virtual network, delivering an affordable, scalable 'Network as a Service' model. Oceus has strategic partnerships with global mobile network operators that can get 5G mobile devices up and running today.

To learn more about how Oceus MOCN neutral host and private 5G network solutions can achieve reliable indoor cellular coverage, visit us at Oceus.io.

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Oceus Your Partner for Mission-Critical Mobile Connectivity

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Oceus brings a heritage of innovation to solving tough business and operations problems, delivering customer-proven private mobile network solutions in challenging environments where reliability and data security are paramount. Oceus is powered by an R&D engine that has yielded over 30 patents. Our success is in providing mobile communications support systems for high stakes military and emergency services who trust Oceus with their **critical operational missions** that require extremely reliable and highly secure communications systems.

OCEUS.IO T 877.816.2599 F 703.234.9201